PHY 342 HW Ch.4c

q4.9
For the first three lines in the Lyman series of the He^+ ion, give the numerical values of the photon energies in eV, and the wave numbers in cm^{-1}. What is the limit of this series?

q4.10
(a) For what states $(s, p, d, ...)$ does the wave function of the hydrogen atom vanish at the origin, i.e., for what l does $R_{nl}(0) = 0$? (b) Briefly explain with classical physics arguments.

q4.11
The hydrogen atom is in state $n = 3$. What is the energy of the state in eV? What is the degeneracy? List all possible quantum numbers l and m.

q4.12
The wave function of a hydrogen atom is initially $\Psi(t = 0) = A\psi_{200} - \frac{1}{\sqrt{2}}\psi_{300}$. (a) Find A such that Ψ is normalized. (b) What are the probabilities of finding the atom in state $n = 1$, 2, and 3? (c) Graph (on a computer) the wave function $\Psi(t = 0)$ using convenient units. Determine graphically where the maximum radial distribution is.
[extra credit] Animate the evolution of the wave function in time, using Python, for instance.

q4.13
Sketch qualitatively the energy level diagrams of the infinite spherical well and of the hydrogen atom. Each diagram should be grouped by $l-$bands horizontally ($l = 0, 1, 2$). List at least one common feature and three different features between them.

q4.14
Show that (a) $[L_+, L_-] = 2\hbar L_Z$; (b) $L^2 = L_-L_+ + \hbar L_Z + L_Z^2 = L_+L_- - \hbar L_Z + L_Z^2$; (c) $L_Z = -i\hbar\partial/\partial\varphi$ in spherical coordinates.